

5.6 TIME-OF-FLIGHT (TOF) SCINTILLATOR COUNTERS

The TOF serves to a) be a fast trigger to the experiment for traversal of a particle across the bore of Cryomagnet and Silicon Tracker, b) measure the particles traversing the detector to a resolution sufficient to distinguish between upward and downward traveling particles and c) measure the absolute charge of the particle. Particles that pass through the scintillators generate photons as they pass through the counter paddles, these events detected by groups of two or three sensitive photomultiplier tubes (PMT) on either end of the detector element, the counter paddles.

The TOF is composed of four planes of detectors, two atop the AMS tracker, two below as shown in Figure 5.6-1. Numbered from the top down, detector assemblies 1, 2 and 4 have eight detector paddles per plane and detector assembly 3 has ten. The pairs of detector assemblies are oriented 90° to each other, shown in Figure 5.6-2. This configuration gives a $12 \times 12 \text{ cm}^2$ resolution for triggering particle events over the 1.2 m^2 area the TOF covers.

Each individual detector paddle is made of polyvinyl toluene (a Plexiglas-like material) that is 12 cm wide and 10 mm thick. End paddles of each layer are trapezoidal with a width of 18.5 to 26.9 cm. Each detector paddle is wrapped in aluminized Mylar and enclosed in a cover made of carbon fiber. As the construction is presented in Figure 5.6-3 each detector paddle includes a depressurization pipe to allow for pressure equalization. In the center of each detector is an LED that is used for calibration and testing. At the ends of each panel are light guides which direct the light of scintillation to photo multipliers. These light guides are curved to orient the photomultiplier tubes within the AMS-02 magnetic field for minimum impact to photomultiplier operations.

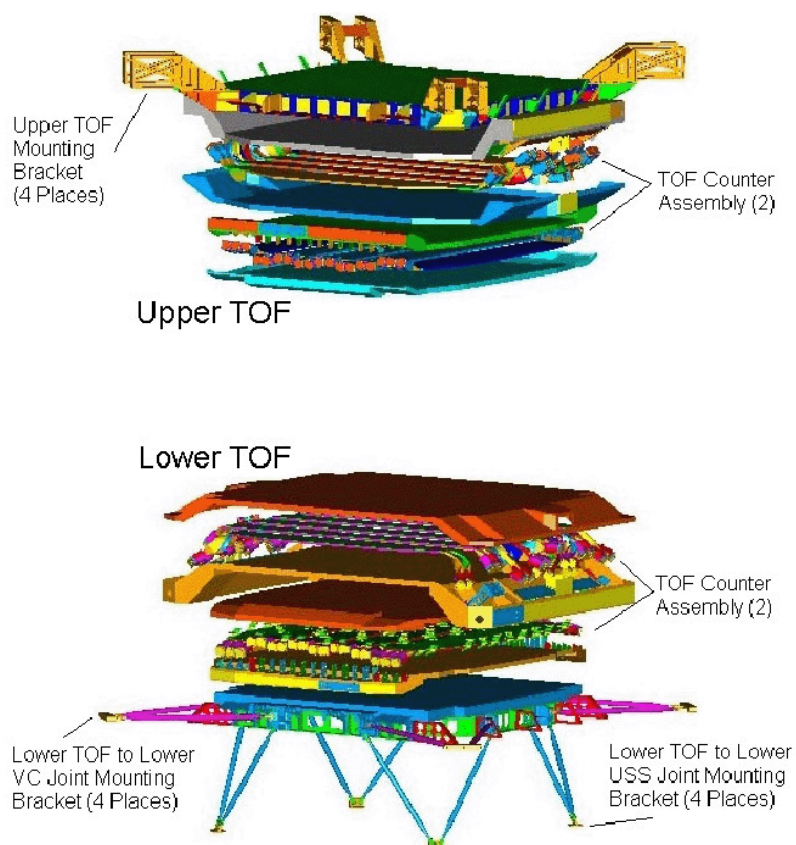


Figure 5.6-1 Time of Flight Counter Construction

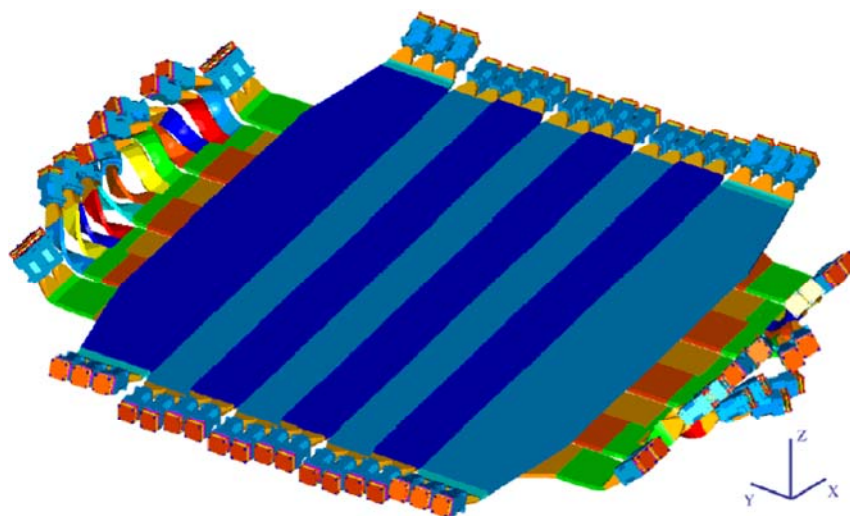


Figure 5.6-2 TOF Detector Paddles Orientation

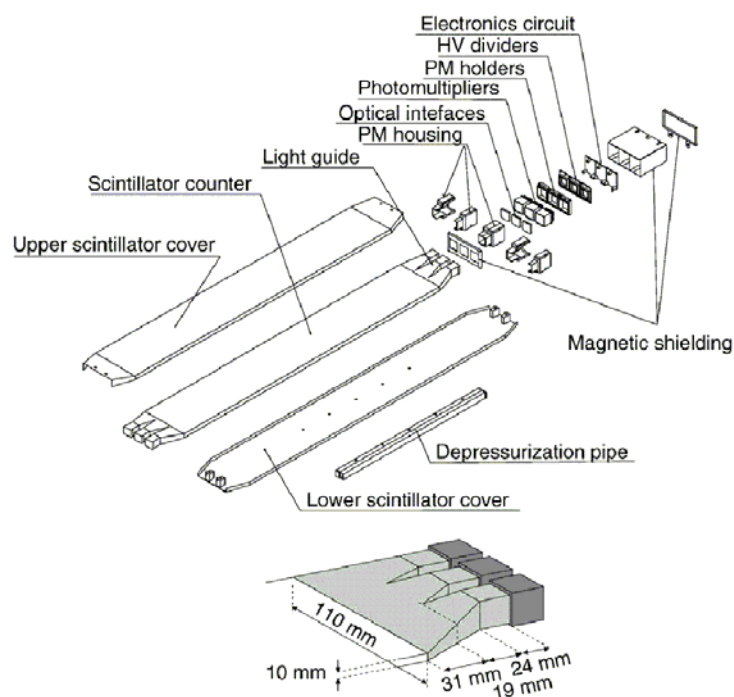


Figure 5.6-3 TOF Detector Paddle Construction

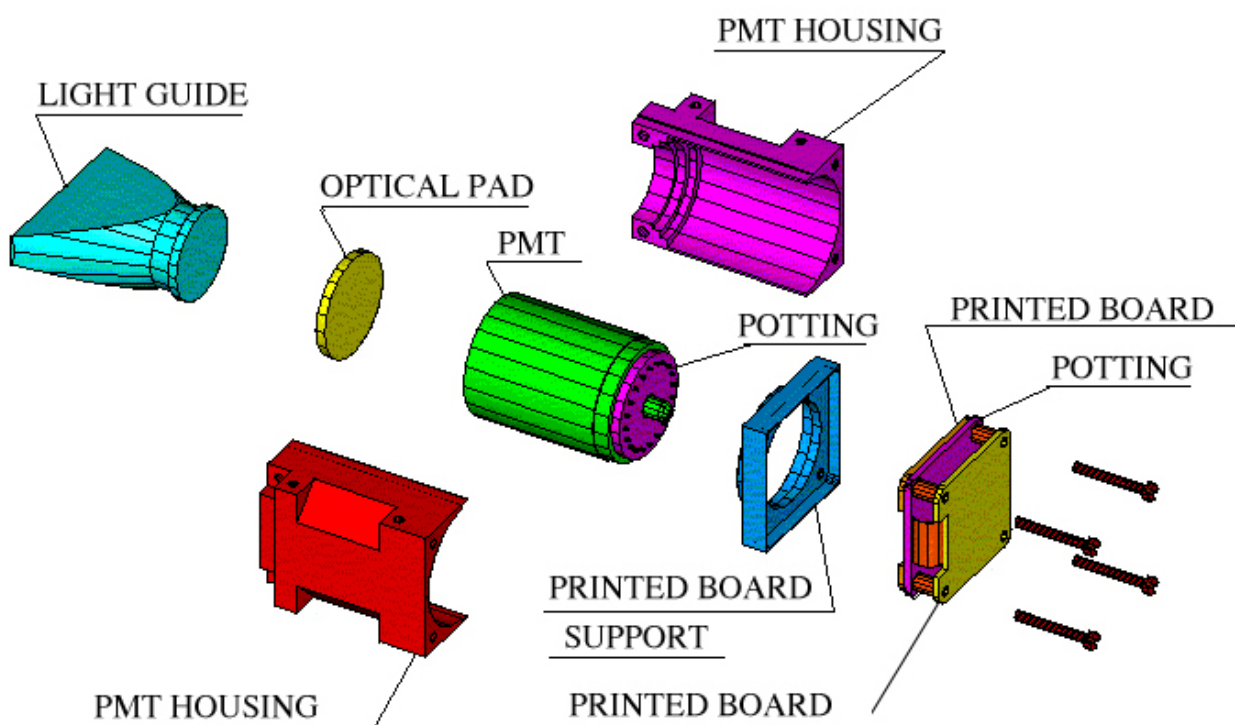


Figure 5.6-4 TOF PMT Exploded View

The TOF is instrumented with 144 Hamamatsu R5946 photomultipliers, used to detect the scintillating light. The PMT operated with a 700-750 Vdc voltage that is supplied by the SHV Crates. Each plane has two printed circuit boards that provide the high voltage sources for the detectors. The design of the TOF has considered the potential of discharge of high voltages at low atmospheric pressures and has implemented potting and coating of the PMT and high voltage interfaces. Access to the insulated and potted high voltage sources by an EVA crewmember is restricted as the TOF are under thermal blankets/MLI. The output from the PMTs on each end of the TOF detectors are summed to provide the necessary triggering signal that is provided to the four S Crates for data processing.

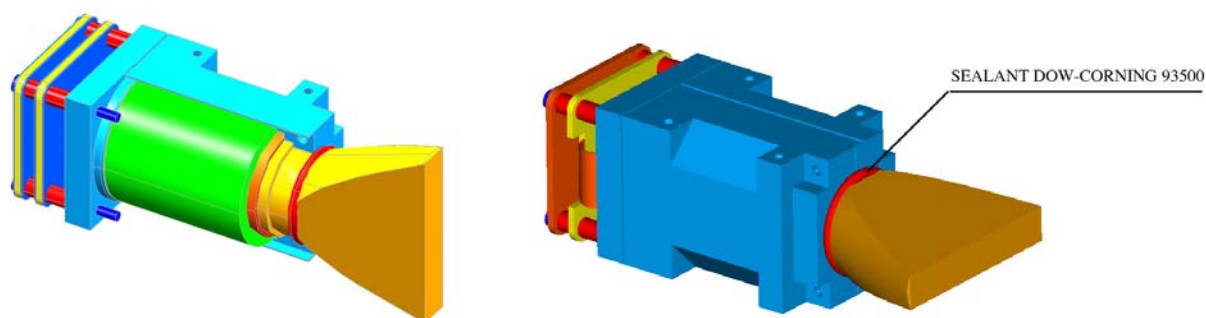


Figure 5.6-5 TOF PMT Construction

The Hamamatsu R5946 PMT is within a PMT housing, shown in Figures 5.6-4 and 5.6-5, made of black polycarbonate that is potted in place. The PMT is pressed into the light guides with an optical pad assuring optical transmission and providing a containment plane for the PMT tube itself.

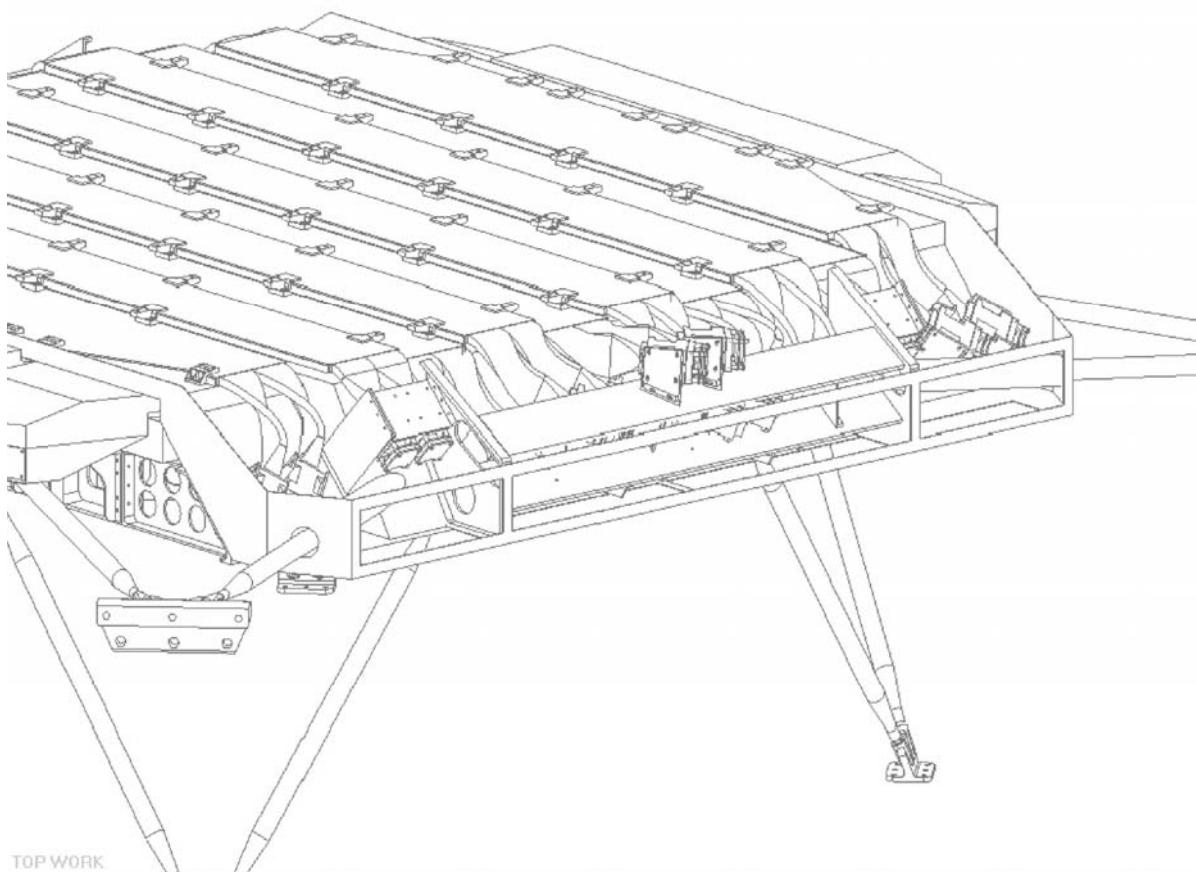


Figure 5.6-6 Mounting of TOF PMT and Detector Paddles

The PMTs are mounted to the TOF structure at orientations that minimize the impact of the magnetic fields on the PMT operations. These orientations can be seen in Figure 5.6-6. Light guides have complex curves to orient the light from the paddles into the carefully oriented PMTs.

Two large flat aluminum honeycomb panels are used to support the scintillator counters. The upper TOF attaches via brackets to the TRD corner joints which hard-mount to the USS-02 upper corner joints (Figure 5.6-7). The lower TOF honeycomb is supported to the lower USS-02 (Figure 5.6-8). The honeycomb panels are roughly circular with a 60.6 inches (1540 mm) equivalent outside diameter. The thickness of the honeycomb aluminum core is 1.97 inches (50 mm) and the aluminum skin is 0.04 inch (1 mm) thick.

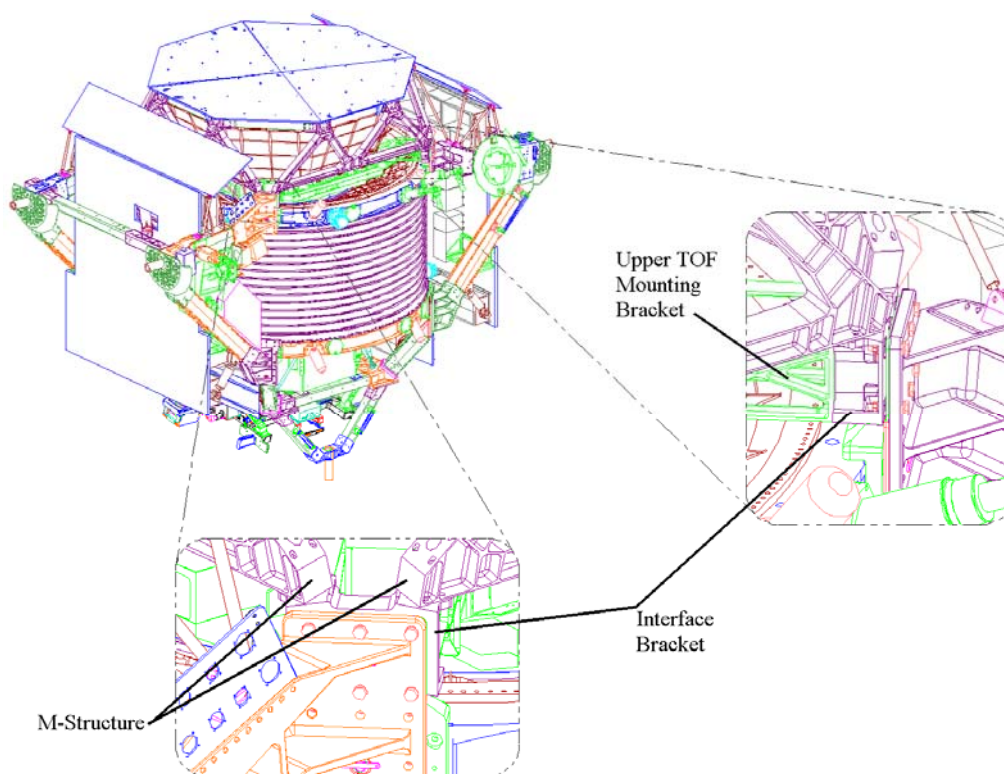


Figure 5.6-7 Structural Interfaces for the Upper TOF

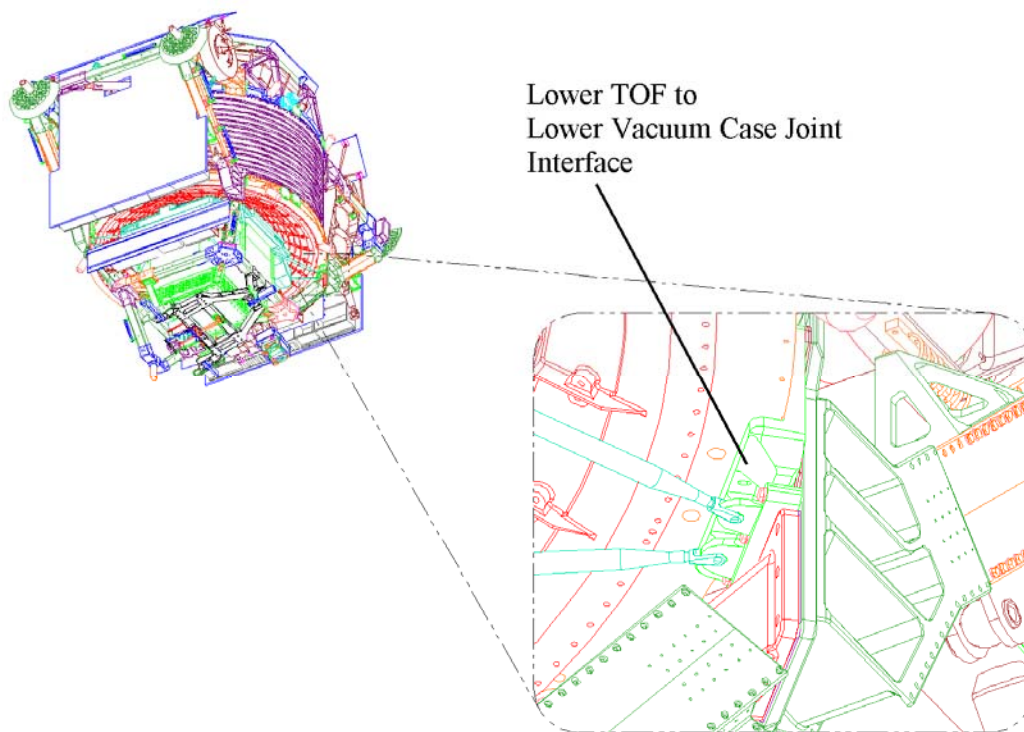


Figure 5.6-8 Structural Interfaces for the Lower TOF